PATENT SPECIFICATION

761,937

Date of Application and filing Complete Specification: Aug. 12, 1954.

No. 23425/54.

Application made in United States of America on Aug. 21, 1953.

Complete Specification Published: Nov. 21, 1956.

Index at acceptance:—Classes 110(1), C4C2, D4A2; and 110(3), B9B, G6.

COMPLETE SPECIFICATION

Improvements in or Relatin g to a Rotary Fluid Pressure Converting Device such as a Turbine, Compressor, Pump or the like

We, THE GARRETT CORPORATION, a corporation organised under the laws of the State of California, United States of America, of 9851 Sepulveda Boulevard, Los Angeles, California, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a rotary fluid pressure converting device, *i.e.*, a rotor assembly such as a turbine, compressor, pump or the like, wherein there is an interchange of energy between the rotor and a fluid, and more specifically to the provision of means for increasing the efficiency and utility of centrifugal compressors, centripetal turbines or like apparatus.

The present invention provides a rotary fluid pressure converting device comprising a rotor rotatably mounted within a casing and having primary blading thereon, secondary blading associated with the rotor, and passage means for contiguously conducting the flow of primary blading fluid and of secondary blading fluid, said passage means being so positioned that the flow of secondary blading fluid forms a flow boundary layer thereabout.

The present invention also provides a rotary fluid pressure converting device comprising a rotatably mounted rotor wheel enclosed by a casing having an inlet port and a discharge port, an axial flow fan mounted on the rotor wheel, and a discharge duct communicating with the discharge port and the axial flow fan and positioned so that the fluid discharged through the duct by the rotor wheel flows concentrically within the fluid discharged through the duct by the axial flow fan.

The present invention further provides a rotary fluid pressure converting device comprising a drive shaft, an impeller fixed for rotation on the shaft, a casing enclosing the impeller for conducting the fluid flow therefrom, axial flow fan or pumping means mounted on the impeller, and an intake passage or duct positioned so that the fluid flowing through the intake passage or duct to the impeller flows within the fluid flowing through the intake passage or duct to the axial flow fan or pumping means.

In rotary fluid pressure converting devices, such as centrifugal compressors that draw their supply of air through an inlet duct, or centripetal turbines that discharge air through an outlet duct, the efficiency of the apparatus is dependent upon a smooth and even entrance or exit of the air. If, for example, the air flowing through a duct to the impeller of a centrifugal compressor is obstructed or impeded by frictional drag on the sides of the duct, the efficiency of the compressor is lowered. Similarly, if the air discharged from the rotor of a centripetal turbine is obstructed or impeded by frictional drag on the sides of the duct, the efficiency of the turbine is reduced.

The invention is herein discussed as applied to a rotary fluid pressure converting device for use with air. It is not, however, limited to such usage, but rather it has utility in compressors and turbines operating with any elastic or gaseous fluid, and it may also be used in pumps and turbines operating with inelastic fluids or liquids.

It is an object of the invention to provide novel means to increase the efficiency of rotary fluid pressure converting devices of the type that utilizes a duct either to convey fluid to an impeller or to conduct fluid from a turbine rotor.

Another object of the invention is to provide a new and novel rotary fluid pressure converting device adapted to simultaneously utilize or deliver fluid at different volumes and pressures.

It is a further object of the invention to provide a novel rotary fluid pressure converting device requiring a minimum of power loss in its operation.

Still another object of the invention is to provide a novel impeller member adapted to deliver separate supplies of fluid at different volumes and pressures.

Another object of the invention is to provide a novel turbine rotor.

Another object of the invention is to provide a novel impeller.

Another object of the invention is to provide a novel turbine.

Another object of the invention is to provide a novel compressor or pump.

Other objects of the invention will become apparent from the disclosure in the following specification and appended claims, taken in connection with the accompanying drawings, which is for illustrative purposes only, and wherein like reference numbers indicate like parts:

Fig. 1 is a sectional view of a centrifugal compressor embodying the invention, and

Fig. 2 is an isometric view of the impeller member of the compressor.

Referring to the drawings, the compressor impeller member 11 is mounted on the end of a drive shaft 12 and secured against rotation relative thereto by a keyed connection 13.

The impeller member 11 is designed to deliver a plurality of air streams simultaneously, at different volumes and pressures, and comprises a compressor portion 14 adapted to deliver a volume of compressed air and a fan portion 15 formed to supply a quantity of air at low pressure.

The compressor portion 14 is shown here as a conventional compressor impeller formed by mounting, on one surface of a circular disk 16, a plurality of substantially radially disposed impeller blades 17, having their entry edges 18 bent in the direction of rotation to provide smooth entry of the air.

The impeller member 11 is secured on the drive shaft 12 by a washer 19 and a nut 20. The drive shaft 12 is journalled within a bearing 21, located in a carrier 22, and may be further supported by other bearings not shown.

The compressor portion 14 is journalled to rotate within a housing having, as a portion thereof, a main casing 23 recessed as at 24 to form the rear wall of an impeller chamber 25. The impeller chamber 25 is surrounded by a diffuser passage 26 wherein a plurality of guide vanes 27 direct the compressed air smoothly into a volute discharge chamber 28. A connection flange 29 is fixed on the discharge end of the volute discharge chamber 28 for ease of assembly to an adjoining duct, not shown. While the diffusor passage and the volute discharge chamber are shown as being formed as one casting integral with the main casing 23, it will be understood by those skilled in the art that these elements may be sectionally fabricated and assembled in many different ways.

The impeller fan portion 15 consists of a plurality of peripherally spaced blades 30 formed on a cylindrical ring 31 which is mounted on the periphery of the entry edges 18 of the impeller blades 17. The fan is of the axial flow type and is designed to deliver a quantity of air at low pressure. The blades 30, for purposes of illustration, are shown in the form of generally flat blades annularly disposed with respect to the plane of rotation.

Attached to the main casing 23 is a septum 32 that defines on one side, the forward wall of the impeller chamber 25, and on the other side the rearward wall of an air passage 33 leading from the low pressure fan 15. An inner annular vane supporting member 34, spaced from the septum 32 but supported therefrom by a plurality of spaced vanes 35, defines the forward wall of the air passage 33.

An air collector 36 bounded by an inner annular wall 37 attached to the vane supporting member 34, an outer annular wall 38 attached to the septum 32, and an end portion 39 is provided to conduct the low pressure air from passage 33 to an outlet 40.

Centrally located within an air inlet passage 41, and defined by the annular wall 37, a hollow fairing cone 42 is supported from the wall 37 by a plurality of circumferentially spaced struts 43.

In operation, when the impeller member 11 is rotated, a supply of air is drawn axially through the air inlet passage 41 to the compressor portion 14 and the fan portion 15. That portion of the air propelled by the fan blades 30, through passage 33 and into the air collector ring 36, may be utilized for heat transfer purposes, for example, or in many other ways which will suggest themselves to those skilled in the art. The remainder of the air flowing through the air inlet passage 41 enters the inlet of the compressor portion 14 and is impelled radially to the volute discharge chamber 28 where it is discharged under high pressure, to be used as required.

The air drawn through the inlet passage 41 to the fan portion 15 flows in an annular stream adjacent the wall 37 and thereby forms a boundary layer flow within the inlet passage. The air flowing through the inlet passage to the compressor portion 14 flows concentrically within, and laminar with, the boundary layer of air flowing to the fan portion. Due to this concentric pattern of laminar flow, disturbances caused by frictional drag on the sides of the duct are

eliminated from the stream of air flowing to the compressor portion of the impeller. Removal of these disturbances or obstructions in the stream of air flowing to the compressor markedly increases its efficiency.

An additional increase in the general efficiency of the compressor is obtained due to the annular ring 31 serving as a seal to prevent the high pressure air in the impeller chamber 25 from leaking back past the blade tips of the compressor impeller and creating turbulence in the stream of air flowing to the impeller.

The invention has special utility when applied in the manner described above to a unit such as a gas turbine compressor in which it is required to provide simultaneously a major volume of compressed air at high efficiency for combustion and other purposes, and a further quantity of air to be used as a cooling medium in a heat exchanger for cooling lubricating oil. The invention not only provides for the supplying of two streams of air simultaneously, but, due to the increase in the efficiency of the compressor portion resulting from the improved flow pattern within the inlet passage, it expends a minimum of power in so doing. It has been found by comparison, for example, that the power expended in operating a centrifugal compressor, having a three-bladed axial flow fan mounted as described above to supply a quantity of air used for oil cooling purposes, is no greater than the power consumed in operating a compressor of identical size without the axial flow fan arrangement.

Although the invention has been described, by way of illustration, with particular reference to an axial flow fan mounted on the entry portion of a compressor impeller, it will be appreciated that the principles herein set forth may be employed to good advantage in other forms. For example, the centrifugal compressor shown in the drawing will operate as a centripetal turbine if the flow is reversed, with air under pressure supplied to the volute at the connection flange 29. In such a case the axial flow fan blades 30 would operate to draw air in through the outlet 40 and to force it leftwardly in the direction of discharge of the main air flow from the turbine rotor along the inner annular wall 37. A concentric pattern of flow would thus be formed within what has in this instance become the turbine discharge duct, and the discharge from the turbine, flowing within the air discharged by the fan, would be substantially free of disturbances caused by skin friction. The removal of these frictional disturbances in the discharge stream of the turbine increases the efficiency of the turbine, and it would, of course, be entirely feasible to employ the flow of fan air for useful purposes by drawing it in as a coolant through a heat exchanger connected to what formerly was the outlet 40.

It will be apparent to those skilled in the art that further variations may also be effected in the arrangement and structure described without departing from the spirit and scope of the invention, and that the principles of the invention may be applied to apparatus such as pumps and turbines operating with inelastic fluids or liquids.

What we claim is :—

1. A rotary fluid pressure converting device comprising a rotor rotatably mounted within a casing and having primary blading thereon, secondary blading associated with the rotor, and passage means for contiguously conducting the flow of primary blading fluid and of secondary blading fluid, said passage means being so positioned that the flow of secondary blading fluid forms a flow boundary layer thereabout.

2. A device according to claim 1, wherein the secondary blading is mounted on the primary blading, and a duct communicates with the rotor and the secondary blading and is positioned so that the primary blading fluid and the secondary blading fluid flow in a concentric pattern therein.

3. A device according to claim 1 or 2, wherein said secondary blading comprises a fan coaxially associated with the rotor.

4. A rotary fluid pressure converting device comprising a rotatably mounted rotor wheel enclosed by a casing having an inlet port and a discharge port, an axial flow fan mounted on the rotor wheel, and a discharge duct communicating with the discharge port and the axial flow fan and positioned so that the fluid discharged through the duct by the rotor wheel flows concentrically within the fluid discharged through the duct by the axial flow fan.

5. A device according to claim 4, having passage means for delivering fluid to the axial flow fan.

6. A rotary fluid pressure converting device comprising a drive shaft, an impeller fixed for rotation on the shaft, a casing enclosing the impeller for conducting the fluid flow therefrom, axial flow fan or pumping means mounted on the impeller, and an intake passage or duct positioned so that the fluid flowing through the intake passage or duct to the impeller flows within the fluid flowing through the intake passage or duct to the axial flow fan or pumping means.

7. A device according to claim 6, wherein the casing has a volute discharge chamber, and the intake passage or duct communicates with the impeller and the axial flow fan and is positioned so that the fluid

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flowing through the duct to the impeller flows concentrically within the fluid flowing through the duct to the axial flow fan.

8. A device according to claim 6 or 7, wherein said axial flow fan is adapted to deliver low pressure fluid, and passage means is provided for delivering low pressure fluid from the axial flow fan.

9. A device according to claim 6, 7 or 8, wherein said impeller has a number of peripherally spaced blades for delivering high pressure fluid, each of said blades comprising a generally radially disposed main portion and an entry portion bent toward the direction of rotation, and said axial flow fan is mounted on the entry portions of the impeller blades.

10. A device according to claim 6, 7, 8 or 9, having duct means for delivering low pressure fluid from the axial flow fan, the duct means forming an inlet passage through which fluid flowing to the impeller flows concentrically within the fluid flowing to the axial flow fan.

11. A device according to any of the preceding claims 1 to 3 or 6 to 10, comprising an impeller having a number of peripherally spaced blades for delivering high pressure fluid, each of said impeller blades comprising a generally radially disposed main portion and an entry portion bent toward the direction of rotation, a casing to house the impeller and conduct its flow of fluid, and a fan for delivering low pressure fluid comprising a plurality of blades angularly disposed with respect to the plane of rotation thereof and fixed on the entry portions of the impeller blades.

12. A device according to any of the preceding claims 1 to 3 or 6 to 11, wherein said casing has a volute discharge chamber, a compressor impeller concentrically rotatable within the casing and having a plurality of peripherally spaced blades with entry portions bent toward the direction of rotation, a fan for delivering low pressure fluid comprising a plurality of blades angularly disposed with respect to the plane of rotation thereof and mounted on the entry portions of the compressor impeller blades, and duct means for delivering low pressure fluid from the fan, said duct means forming an inlet passage communicating with the fan and the impeller and located so that the fluid flowing to the impeller flows concentrically within the fluid flowing to the fan.

13. A device according to claim 1, wherein said rotor comprises a disc, a plurality of peripherally spaced vanes or blades projecting from one face of the disc, an annular ring secured to the vanes or blades, and a plurality of fan blades fixed on the annular ring.

14. A device according to claim 13, wherein said vanes are fixed on one face of the disc, each having a generally radially disposed portion and a forwardly curved portion, and said annular ring is secured to the forwardly curved portions of the vanes, and said fan blades are angularly disposed with respect to the radially disposed portions of the vanes.

15. A fluid pressure converting device constructed substantially as herein described with reference to Figures 1 and 2 of the accompanying drawings.

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Sheerness : Printed for Her Majesty's Stationery Office, by Smiths, Printers and Duplicators.—1956.
Published at The Patent Office, 25, Southampton Buildings, London, W.C.2, from which copies may be obtained.

761,937 COMPLETE SPECIFICATION
1 SHEET

This drawing is a reproduction of the Original on a reduced scale.

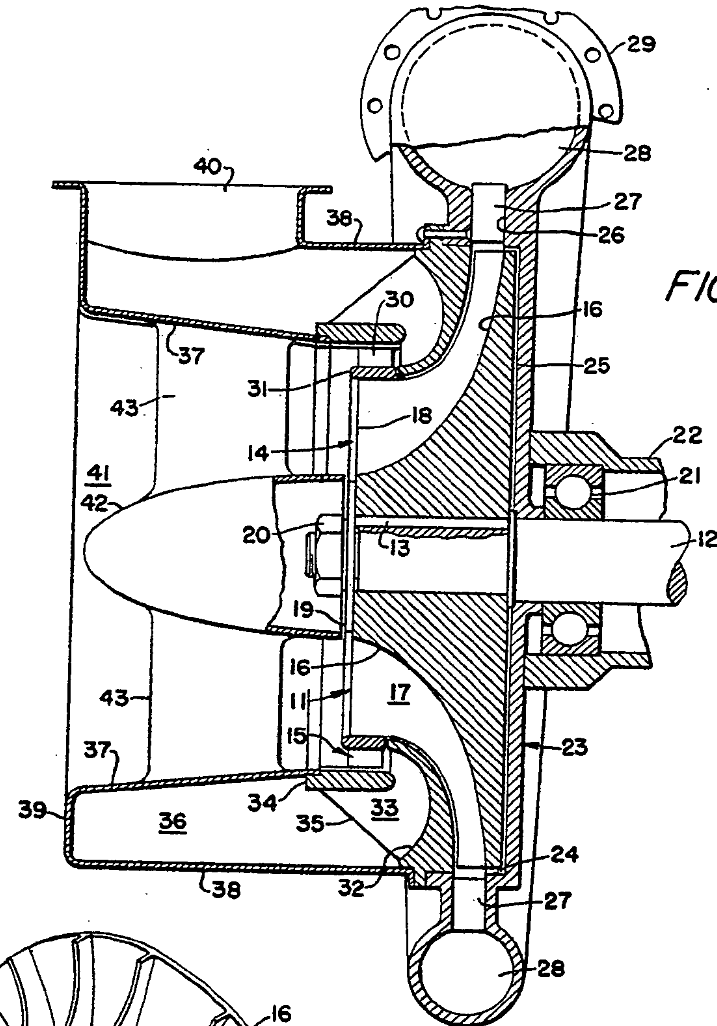

FIG. 1.

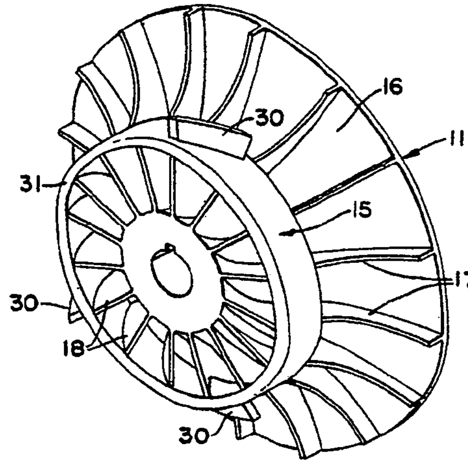

FIG. 2.